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DETERMINING THE AGRONOMIC EFFECTS OF SOIL APPLIED POULTRY MANURE ON ANNUAL CROP PRODUCTION

FINAL REPORT

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Final Report

Determine the Agronomic Effects of Soil Applied Poultry Manure on Annual Crop Production

by

Saskatchewan Egg Producers and PAMI

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Table of Contents

Page

1. Summary 1

2. Background and Objectives 3

3. Project Description 4

4. Results and Discussions 10
   - 4.1 PAMI Analysis 2001 10
   - 4.2 University of Saskatchewan Analysis 2001 – Dr. Jeff Schoenau 12
   - 4.3 PAMI Analysis 2002 15
   - 4.4 University of Saskatchewan Analysis 2002 16
   - 4.5 PAMI Analysis 2003 19
   - 4.6 University of Saskatchewan Analysis 2003 20

5. Conclusions 24

6. Personnel 25
   - 6.1 PAMI Manpower Supplied 25

7. Project Schedule 26

Appendix I Poultry Manure Analysis 27

1. Summary

The research commenced in Spring 2001 and continued until Fall 2003 with this final project report in Spring 2004.

Project activities were initiated with the establishment of a research site location, the test plot layout, and staking at this site. These activities were performed in Fall 2000 in preparation for the fall application of poultry manure on the test plots. However, due to spreader equipment breakdowns experienced by the custom operator contracted to spread the poultry manure, fall application of the manure did not occur. The manure application was carried out on May 5, 6, and 7, 2001 by a different contractor. Spring soil sampling of check areas showed that overall soil available nitrogen was rather low, so a response to manure nitrogen was expected. The manure was worked into the plots, then the plots were seeded May 19 to canary seed and harvested August 27 and 28, 2001.

In general, limited rainfall in 2001 resulted in poorer than usual yields. With the exception of the 2 tons/ac (4.5 tonnes/ha) rate, each increase in manure application rate resulted in incrementally higher seed yield.

Fall 2001 soil tests showed that only the 16 tons/ac (35.9 tonnes/ha) and 32 tons/ac (71.7 tonnes/ha) rates produced higher residual nitrogen than the check areas with most of the excess nitrogen in the top 12 in (30 cm) and slight increase at the 12 to 24 in (30 to 60 cm) depth.

In Spring 2002, the test area was again seeded to canary seed on May 28. Soil moisture conditions at seeding were adequate for seed germination and emergence. Yields were also low in 2002 due to early drought stress, weed competition, and grasshopper damage. Only the 16 and 32 tons/ac (35.9 and 71.7 tonnes/ha) rates applied in Spring 2001 had significant enough residual effect to boost yield in 2002. The lower manure application rates of 2, 4, and 8 tons/ac (4.5, 9.0, and 17.9 tonnes/ha) had no increase in residual N, compared to the check resulting in no yield response with these treatments.

Soil characteristics in the 0 to 6 in (0 to 15 cm) depth were analyzed in Spring 2003 to determine the soil quality effects of a single manure application in Spring 2001. Changes in soil quality included an increase in organic carbon at the highest application rate and increases in total N, total P, and total K as manure rates increased.

In Spring 2003, the test area was again seeded to canary seed on May 18 at a seed rate of 34 lb/ac (38 kg/ha). Moisture conditions were adequate for germination and emergence. Canary seed yields were low again due to drought and grasshoppers. Only

the 16 and 32 tons/ac (36 and 72 tonnes/ha) rates had significantly higher yields compared to the check.

Poultry manure application had little effect on salinity or pH due to the highly buffered clay soil at the plot location. Organic carbon increased significantly only at the 32 tons/ac (71.7 tonnes/ha) rate.

Based on an analysis of all data, a manure application rate of 16 tons/ac (35.9 tonnes/ha) once every three years may be the best management practice. The high P content of poultry manure shows that there is a need to mention P loading when determining application rates. The sulphate values in the manure in this trial suggest that poultry manure, like cattle manure, may be an adequate source of sulphur.

2. Background and Objectives

Poultry operations in western Canada have traditionally stockpiled or land-applied manure. Expansion of the industry will depend on the development of manure management plans that include sustainable spreading of manure on land used for agricultural production. Very little research has been conducted in the Prairie Provinces to determine the crop response and sustainability of broadcast and incorporated poultry manure. Field research was required to determine optimum agronomic and economic methods of field application of poultry manure.

The objective of this project was to evaluate and demonstrate the agronomic effects of broadcast and incorporated poultry manure on annual crop production. All plot treatments were applied in Spring 2001 and the results were monitored until Fall 2003 to determine the long-term benefits of poultry manure application.

3. Project Description

This field research/demonstration project was conducted by Gordon Hultgreen (PAMI) and Dr. Jeff Schoenau (Soil Science, University of Saskatchewan) with support from Dr. S. P. Mooleki. PAMI was responsible for plot design and layout, machinery calibration, manure sampling, supervision of broadcast manure application, and harvesting a small part of each treatment for crop yield and quality. Soil Science was to be responsible for baseline and ongoing soil analysis, manure nutrient analysis, biomass sampling, and tissue analysis. Each of the participants in the project had provided a budget to cover their areas of responsibility, but PAMI was responsible to produce reports, invoice project funding agencies, and to pay the U of S for their work as it was completed.

O and T Poultry cooperated in the project by providing "fresh" poultry manure, loading the manure from the barns to the spreader and providing the use of facilities such as truck weigh scales and other infrastructure to assist the project.

The project was being conducted over three years at one site in the Regina area. Land selected was stubble crop and was to be continuously cropped in cereals or oilseeds until the end of the project. The site is located on relatively level land with no major changes in soil texture, no major weed problems, and with good drainage to prevent water problems on the plots. The site is located two miles from Pasqua Street on the West side of Highway #11 at SW 27, 18, 20, W2nd. The land does not have a history of manure application. Land was selected in Fall 2000 in preparation of the start of the project in Spring 2001. The field was seeded to canary seed in 2001 and 2002. The field project continued until Fall 2003. The farmer cooperator seeded the crop normally each year with the exception that no fertilizer was to be applied on the plot area. Following seeding, the cooperator used weed control similar to the rest of the field. Yield samples were be taken by PAMI from the plots just prior to harvest, and then the farmer cooperator harvested the plot area at his convenience. The farmer cooperator was asked to advise PAMI about one week prior to his preferred swathing date to allow PAMI time to remove harvest samples.

Manure treatments were applied using a truck mounted manure spreader that was capable of applying the required rates of poultry manure. Application rates were calibrated using a truck scale, full manure truckloads, and by measuring the time required to empty the spreader. Ground speed was calibrated using gear and engine rpm settings. Each load applied to the plots was sampled for nutrient analysis.

Plot size was 25 ft (7.6 m) wide by 100 ft (30.4 m) long. Total plot area was 4 ac (1.6 ha), 575 ft (175.2 m) x 300 ft (91.4 m). All plots were replicated four times using a randomized complete block design. The plots at the site were 6 treatments x 4 reps = 24 plots.

Treatments:

1. Check – no manure application
2. Poultry Manure Broadcast and Incorporated @ 2 tons/ac (4.5 tonnes/ha) (0.5 X)
3. Poultry Manure Broadcast and Incorporated @ 4 tons/ac (9.0 tonnes/ha) (1.0 X)
4. Poultry Manure Broadcast and Incorporated @ 8 tons/ac (17.9 tonnes/ha) (2.0 X)
5. Poultry Manure Broadcast and Incorporated @ 16 tons/ac (35.9 tonnes/ha) (4.0 X)
6. Poultry Manure Broadcast and Incorporated @ 32 tons/ac (71.7 tonnes/ha) (8.0 X)

The following sketches (**Figures 1** to **3**) show the plot layout.

Figure 1. General Plot Layout.

Sept 12/00

Poultry Manure Research Plots

*not to scale

Plot Area 575' x 300 = 172500 ft^2 = 4ac

Treatment
1 - Check
2 - 2 t/ac (4.5 tonnes/ha) (0.5 X)
3 - 4 t/ac (9.0 tonnes/ha) (1.0 X)
4 - 8 t/ac (17.9 tonnes/ha) (2.0 X)
5 - 16 t/ac (35.9 tonnes/ha) (4.0 X)
6 - 32 t/ac (71.7 tonnes/ha) (8.0 X)

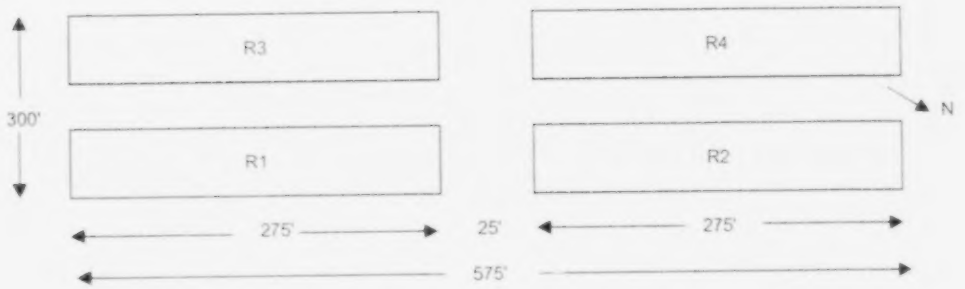

Figure 2. Manure Application.

Poultry Manure Research Plots

*not to scale

Sept 12/00

Plot Area 575' x 300 = 172500 ft^2 = 4ac

Treatment
1 - Check
2 - 2 t/ac (4.5 tonnes/ha) (0.5 X)
3 - 4 t/ac (9.0 tonnes/ha) (1.0 X)
4 - 8 t/ac (17.9 tonnes/ha) (2.0 X)
5 - 16 t/ac (35.9 tonnes/ha) (4.0 X)
6 - 32 t/ac (71.7 tonnes/ha) (8.0 X)

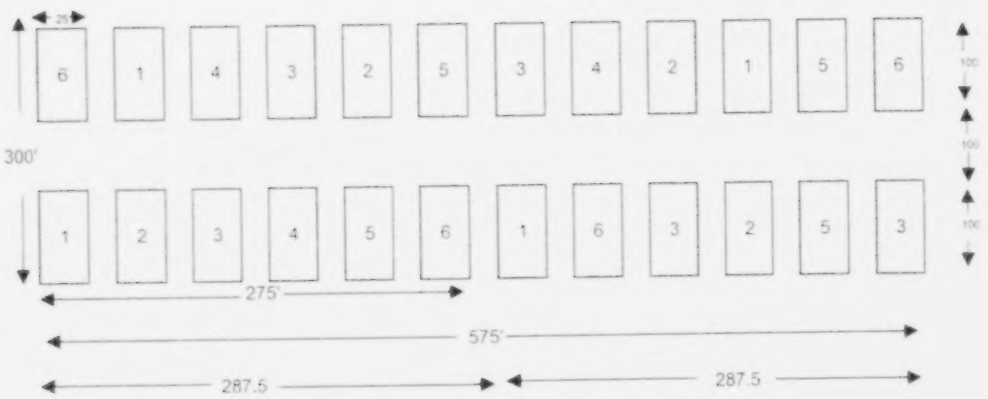

Figure 3. Plot Designation.

Application rates were based on applying sufficient manure N to supply three crop years' production. The 1.0 X rate was based on an O and T barn manure analysis of about 60 lb (27.2 kg) total N/ton for a total of 240 lb (108.9 kg) total N/ac ÷ 3 years = 80 lb (36.3 kg) N/ac/year.

Prior to the start of the project in Spring 2001, Soil Science completed the baseline soil analysis of the site.

In Spring 2001, PAMI staked the individual plots for the site and supervised the application of the manure treatments (**Figure 4**). The broadcast manure was soil incorporated shortly after application using a tandem disc to reduce nutrient losses.

Figure 4. Manure Application.

Following manure application and incorporation, the farmer cooperator pre-worked the plot area and seeded it to canary seed at a seed rate of 30 to 33 lb/ac (33.6 to 37 kg/ha) without using additional fertilizer. The pre-work and seeding were part of the total field operation with the exception of shutting off all commercial fertilizer application in the plot area. After seeding, herbicide was applied as required by the farmer.

On May 28, 2002, the field, including the plot area, was seeded to canary seed at a seeding rate of 30 to 33 lb/ac (34 to 37 kg/ha). Pre-seed tillage was done for weed control and the crop was seeded with a Bourgault 8800 air seeder equipped with 2 in (5.1 cm) spoons and mounted packers. Soil moisture conditions at seeding were

adequate for seed germination and emergence. A tank mix of Puma Super and Buctril M was applied for annual grass and broadleaf weeds.

On May 18, 2003, the field was pre-worked and seeded to canary seed at a seed rate of 34 lb/ac (38 kg/ha). Moisture conditions at seeding were adequate for germination and emergence. Herbicide was applied July 2, 2003 using Puma Super and Buctril M.

Each summer the plots were signed, trimmed, and a field day was conducted to demonstrate the crop response to the applied manure. PAMI trimmed the front of the plots for the tour and provided information and commentary about the project. On July 18, 2002, a tour was conducted with Karen Bolton (Sask Ag & Food) and Tim Wiens (O and T Poultry).

Prior to harvest, Soil Science removed crop samples from an area of 2.39 yd^2 (2 m^2) that were taken from each plot for biomass production, seed yield, and tissue analysis by Soil Science. All plots had a plot-length strip harvested, 4 ft (1.2 m) x 100 ft (30.5 m), with the PAMI small plot combine, as shown in **Figure 5**. Samples were cleaned and weighed and analyzed for protein content.

Figure 5. Small Plot Combine.

In Spring 2002, Spring 2003, and at the completion of the project, Soil Science sampled the plot area and analyzed the soil nutrient status.

In Year 2 and 3 of the project, no manure was applied to the plots. Similar to Year 1, the crop was seeded (without fertilizer). Prior to harvest, the plots were sampled using the previous methodology.

Soil samples from the plots were taken after harvest in Fall 2003.

Following completion of harvest in Year 3, the data was analysed and results are reported herein. Project results were reported at the Soils and Crops Workshop in Saskatoon, Saskatchewan in February 2004.

4. Results and Discussions

4.1 PAMI Analysis 2001

The original scheduled start date of Fall 1999/Spring 2000 for the project was not met due to delays in confirming project funding. As a result, project activities initiated in Fall 2000 included the establishment of a research site location, test plot layout and staking at the research site, and arrangements for manure application by a custom applicator. The application of manure on the test plots was also to occur in Fall 2000, but applicator equipment breakdowns prevented the custom applicator from performing this task. The activities that were performed by PAMI personnel only are indicated in Section 6.

Since the original start date for this three-year project was not met, the project schedule was essentially delayed by one year. Therefore, the field research was started in 2001 and concluded in 2003 rather than beginning in 2000 and concluding in 2002 as originally scheduled. A revised project schedule is presented in Section 7.

In addition to the project schedule changes, one change was made to the original project procedure. At the request of O and T Poultry, an additional treatment of 32 tons/ac (71.7 tonnes/ha) poultry manure (8.0 X) was added to the original 5-treatment plot design. This additional treatment resulted in 1 treatment x 4 reps = 4 extra plots, increasing the number of plots from 20 to 24.

Adding this extra treatment increased budget costs, especially those of U of S Soil Science (see budget numbers). While this increase in costs was difficult to justify with limited budget resources, it was anticipated to make a significant improvement to the project deliverable. The high rate of application should emphasize the agronomic and environmental effects of higher rates of manure application, which are often not considered to be sustainable.

The project's one-year delay has also had an effect on project funding. Funding received from the Canadian Adaptation and Rural Development in Saskatchewan (CARDS) program was to cover project costs according to the original project schedule (field research beginning Spring 2000 and concluding Fall 2002). Due to the one-year delay, the project's conclusion would no longer coincide with CARDS funding deadline of Spring 2003 but now extended into Spring 2004. Funding would either have to be extended, or the final year of the project would have to be provided by TAD and the Saskatchewan Egg Producers. An application was made to CARDS to allow changes in method of payment to facilitate this change and CARDS approved this change.

Section 8 indicates the extension of project activities and associated costs for Years 1 to 3 of the project.

The manure was applied May 5 to May 7, 2001, and the plots were seeded May 19, 2001 to canary seed. Harvesting with the small plot combine was done August 27, 28, and 30, 2001.

In general, limited rainfall in 2001 resulted in poorer than usual yields. With the exception of the 2 tons/ac (4.5 tonnes/ha) rate, each increase in manure application rate resulted in incrementally higher seed yield (**Table 1** and **Figure 6**).

Table 1. Yield Data from Regina Site Fall 2001.

		Rep1			Rep2			Rep3			Rep4			Mean	
	Treatment	kg	lb/ac	kg/ha	kg	lb/ac	kg/ha	kg	lb/ac	kg/ha	kg	lb/ac	kg/ha	lb/ac	kg/ha
Check	1	2.24	576	645	1.74	447	501	1.98	475	532	1.42	365	409	466	522
2 tons/ac	2	1.94	499	559	2.08	535	599	1.46	351	393	1.68	432	484	454	508
4 tons/ac	3	2.62	673	754	2.48	637	714	1.7	408	457	1.92	494	553	553	620
8 tons/ac	4	3.14	780	873	2.16	555	622	2.52	605	678	1.68	432	484	593	664
16 tons/ac	5	3.5	900	1008	2.62	673	754	2.6	624	699	2.48	637	714	709	794
32 tons/ac	6	3.58	920	1031	2.48	637	714	3.58	859	963	2.18	523	586	735	823
		Mean	725	812		581	651		554	620		481	538		

Note that formulas were used for calculating lb/ac change due to changes in plot length from m^2.

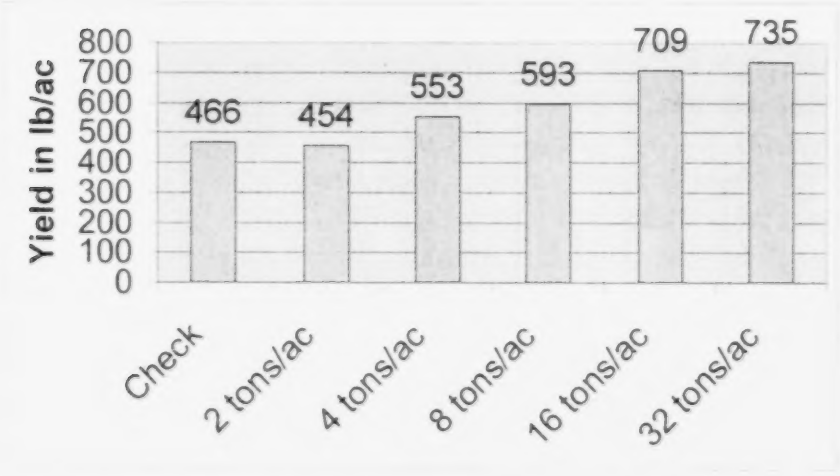

Figure 6. Effects of Poultry Manure on Canary Seed Yield in 2001.

4.2 University of Saskatchewan Analysis 2001 – Dr. Jeff Schoenau

Spring Available Nutrients in Control Plots: (Site Characterization): Available N levels in the soil across the plot area are relatively uniform with the exception of the control plot in block 3 with higher available N than the rest. Overall, available N levels are relatively low, so a response to manure nitrogen is expected at this site. Extractable P is low at this site with the exception of block 3, so a response from P added as manure would also be expected. Extractable K is very high, as would be expected for a soil of high clay content such as this. Soil pH is slightly akaline ~ 8.0 and the E.C. indicates no salinity in the soil profile. Soil sulfate levels are moderate, so a response to sulfur would not be expected.

Yields: Addition of poultry manure at 2 and 4 tons / acre did not produce a significant yield increase of canary seed over the control. Application at 8 tons/acre produced a 100 kg/ha yield increase over the control; and application at 16 tons/acre gave the highest yield ~ 1100 kg / ha. The high rate of 32 tons / acre did not produce significantly higher grain yield over the 16 tons / acre rate.

Fall Residual Inorganic N: Only 16 ton/acre and 32 ton / acre rates produced higher residual inorganic N than the control, and only the 32 ton/acre rate produced significantly higher residual inorganic N. Most of the residual inorganic N at the high rate (32 ton/acre) was present as nitrate (163 kg NO3-N / ha) in the top 30 cm, with a slight elevation in the 30-60cm depth. 32 tons / acre appears to be too much.

2001: Dr. Jeff Schoenau's Poultry Manure Experiment at Regina

Coordinated by Dr. S.P. Mooleki 2001 Spring Soil Sampling (Ckecks only)

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January 22, 2002

Plot	SN	NO1	NO2	NO3	NH1	NH2	NH3	Av.N1	Av.N2	Av.N3
Rep 1	477	10.4	9.2	19.6	7.3	8.8	16.1	17.7	18.0	35.7
Rep 2	479	14.9	3.2	18.0	13.6	16.2	29.7	28.5	19.3	47.8
Rep 3	481	33.4	19.5	52.9	14.5	18.0	32.5	47.9	37.5	85.4
Rep 4	483	10.4	3.2	13.6	15.5	15.5	31.0	25.9	18.6	44.5
Average		**17.2**	**8.8**	**26.0**	**12.7**	**14.6**	**27.3**	**30.0**	**23.4**	**53.4**

Plot	SN	SO1	SO2	SO3	Av.P1	Av.K1	pH1	pH2	pH3	EC1	EC2	EC3
Rep 1	477	83.1	132.7	215.8	16.6	3262	7.99	8.16	8.08	0.26	0.28	0.27
Rep 2	479	108.2	107.3	215.5	16.9	2288	7.83	8.65	8.24	0.27	0.25	0.26
Rep 3	481	83.5	83.7	167.2	37.3	2659	8.57	8.55	8.56	0.29	0.25	0.27
Rep 4	483	83.9	107.9	191.8	17.8	2222	8.69	8.66	8.68	0.31	0.27	0.29
Average		**89.7**	**107.9**	**197.6**	**22.2**	**2608**	**8.27**	**8.51**	**8.39**	**0.28**	**0.26**	**0.27**

NO = NO_3 NH = NH_4 Av.N = Available N (i.e. NO_3 + NH_4)

SO = SO_4 kg/ha (2 M KCl ectracted)

EC = Electrical conductivity (mS/cm)

Av.P and **Av.K** = Modified Kelowna extractable P and K, respectively (kg/ha)

Suffices 1, 2 & 3 denote soil depth 0-30, 30-60 & 0-60 cm, respectively.

2001: Dr. Jeff Schoenau's Poultry Manure Experiment at Regina

Coordinated by Dr. S.P. Mooleki 2001 Canary crop and Fall soil samples

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This file: C:\~Ueff\2001work\Data2001\Crop\01CrpJJPoulTT.xls

December 23, 2001

Means

Tons/ac	Trt	N	GrYld	StYld	ToYld	NO1	NO2	NO3
0	1	4	788 c	1814 b	2601 b	6.7 b	1.9 b	8.6 b
2	2	4	703 c	1741 b	2444 b	7.3 b	2.1 b	9.5 b
4	3	4	745 c	2361 b	3106 b	9.8 b	2.7 b	12.5 b
8	4	4	886 bc	2005 b	2891 b	6.5 b	2.0 b	8.5 b
16	5	4	1096 a	3606 a	4703 a	28.7 b	4.6 b	33.3 b
32	6	4	1026 ab	4070 a	5096 a	163.0 a	12.4 a	175.3 a
		SE	99	302	345	31.9	1.6	32.8
		$LSD_{(0.05)}$	210	644	735	68.0	3.4	69.9
		CV	16.0	16.4	14.0	121.9	52.1	112.4
		MSE	19500.0	1827234.0	237767.0	2054.0	4.9810	2153.0
		Gr.Mean	873.9	2599.6	3473.6	37.0	4.3	41.3

Tons/ac	Trt	N	NH1	NH2	NH3	Av.N1	Av.N2	Av.N3
0	1	4	14.0	14.8	28.8	20.7 b	16.8 b	37.4 b
2	2	4	13.3	15.2	28.4	20.6 b	17.3 b	37.9 b
4	3	4	12.5	13.2	25.7	22.3 b	15.9 b	38.2 b
8	4	4	13.8	15.1	28.9	20.3 b	17.1 b	37.4 b
16	5	4	13.2	15.7	28.9	41.9 b	20.3 b	62.2 b
32	6	4	18.0	15.6	33.7	181.0 a	28.0 a	209.0 a
		SE	2.5	2.6	4.0	32.3	3.5	34.3
		$LSD_{(0.05)}$	5.4	5.5	8.5	68.8	7.4	73.0
		CV	25.3	24.5	19.5	89.3	25.7	68.9
		MSE	12.790	13.430	31.050	2985.0	24.930	2348.0
		Gr.Mean	14.1	15.0	29.1	51.1	19.2	70.4

Key: Gr = Grain St = Straw To = Gr + St (all in kg/ha)
NO = NO_3 NH = NH_4 Av.N = Available N (i.e. NO_3 + NH_4) (all in kg N/ha)
Suffices 1, 2 & 3 denote soil depth 0-30, 30-60 & 0-60 cm, respectively. $T_{(0.05, 15df)}$ = 2.131

4.3 PAMI Analysis 2002

In Fall 2001, soil tests showed that only the 16 tons/ac (35.9 tonnes/ha) and 32 tons/ac (71.7 tonnes/ha) rates produced higher residual nitrogen than the check areas with most of the excess nitrogen in the top 12 in (30 cm) and with slight increase at the 12 to 24 in (30 to 60 cm) depth.

In Spring 2002, the crop was again seeded to canary seed on May 28. Soil moisture conditions at seeding were adequate for seed germination and emergence. A tank mix of Puma Super and Buctril M was used for weed control with limited success, as plots were quite weedy. Yields were also low in 2002 due to early drought stress, weed competition, and grasshopper damage. In 2002, only the 16 and 32 tons/ac (35.9 and 71.7 tonnes/ha) rates applied in Spring 2001 had significant enough residual N effect to boost yield in 2002. The lower manure application rates of 2, 4, and 8 tons/ac (4.5, 9.0, and 17.9 tonnes/ha) had no increase in residual N compared to the check resulting in no yield response with these treatments (**Table 2** and **Figure 7**).

Table 2. Yield Data from Regina Site Fall 2002.

		Rep1			Rep2			Rep3			Rep4			Mean	
	Treatment	kg	lb/ac	kg/ha	kg	lb/ac	kg/ha	kg	lb/ac	kg/ha	kg	lb/ac	kg/ha	lb/ac	kg/ha
Check	1	3.2	768	860	2.22	533	597	1.8	432	484	1.76	423	473	539	604
2 tons/ac	2	2.4	576	645	2.08	499	559	1.52	365	409	1.96	471	527	478	535
4 tons/ac	3	2.48	595	667	2.66	639	715	1.62	389	436	1.62	389	436	503	563
8 tons/ac	4	2.54	610	683	2.14	514	575	1.62	389	436	0.92	221	247	433	485
16 tons/ac	5	2.38	571	640	2.22	533	597	2.2	528	592	2.72	653	731	571	640
32 tons/ac	6	2.44	586	656	2.64	634	710	2.3	552	618	2.16	519	581	573	641
		Mean	618	692		559	626		443	496		446	499		

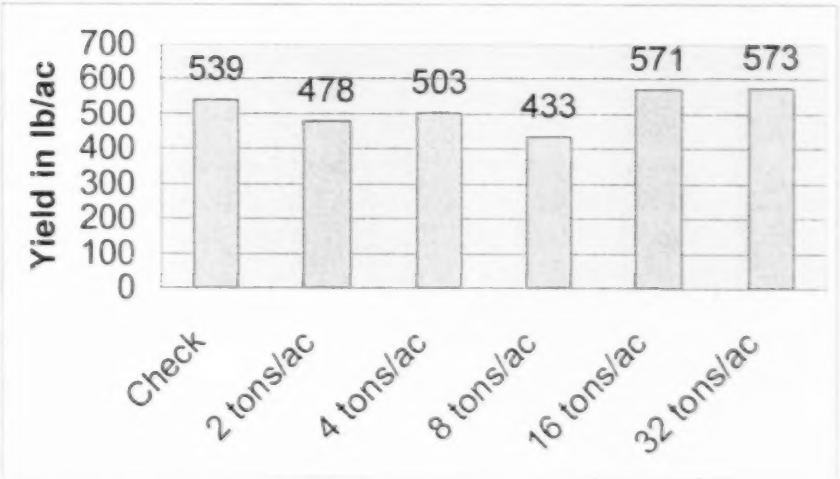

Figure 7. Effect of Poultry Manure on Canary Seed Yield 2002.

4.4 University of Saskatchewan Analysis 2002

4.4.1 Spring Available N, P, K, pH, E.C.

Poultry manure applied in the spring of 2001 had relatively little impact on available N, except for the 16 and 32 tons/ac (35.9 and 71.7 tonnes/ha) rates that produced a significant elevation. Extractable K was not significantly affected by manure addition at the lower rates of application, not surprising since these soils have very high indigenous K fertility due to their high clay content, but the high rate produced a significant increase in soil extractable K. A similar trend was observed with extractable P. The extractable P was significantly higher in the 32 tons/acre (71.7 tonnes/ha) treatment compared to the rest of the treatments, with the 32 tons/acre (71.7 tonnes/ha) rate having about 53 lb/ac (60 kg) extractable P / ha 0 to 30 cm depth compared to about 20 kg (17.6 lb/ac) extractable P / ha in the other treatments. The high rate of 32 tons/ac (71.7 tonnes/ha) also caused a small but statistically significant increase in electrical conductivity (salinity), which is indicative of some accumulation of soluble salts at this rate.

4.4.2 Canary Seed Yield

Poor early weed control and dry soil conditions early in the spring likely reduced the yield potential compared to the previous year. Only the 16 and 32 tons/ac (35.9 and 71.7 tonnes/ha) rates applied in the spring of 2001 had a significant enough residual effect to boost yield in Year 2 (2002). Yields increased from ~ 444 lb/ac (~ 500 kg/ha) in the control and low rate treatments to around 622 lb/ac (700 kg/ha) in the 16 and 32 tons/ac (35.9 and 71.7 tonnes/ha) rate. The 16 tons/acre (35.9 tonnes/ha) rate gave the optimal canary seed yield in 2001 and again in 2002. The 32 tons/ac (71.7 tonnes/ha) rate was the only treatment with significantly higher residual soil available N in the fall after harvest.

Based on the first two years of data, a single application of 16 tons/ac (35.9 tonnes/ha) may be best to optimize plant nutrition for two years and minimize nutrient and salt accumulation in the soil.

2002: Dr. Jeff Schoenau's Poultry Manure Experiment at Regina

Coordinated by Dr. S.P. Mooleki — **2002 Canary yield, and Spring and fall Soil Sampling**

This file: C:\~\Jeff\2002work\Data2002\Combined\02Crop&SL1&2JJPoulAV.xls
This file: C:\~\Jeff\2002work\Data2002\Combined\02Crop&SL1&2JJPoulTT.xls

January 16, 2003

MEANS

SPRING SOIL SAMPLES

Tons/ac	Trt	N	Avail. N			Av.K	Av.P	pH			EC (mS/cm)		
			0-30	30-60	0-60	0-30	0-30	0-30	30-60	0-60	0-30	30-60	0-60
0	1	4	33 c	19	52 b	2158 bc	21 b	7.20	7.29	7.24	0.282 b	0.261	0.272 b
2	2	4	31 c	20	52 b	1986 bc	21 b	7.12	7.17	7.14	0.275 b	0.264	0.269 b
4	3	4	31 c	17	49 b	1953 bc	19 b	7.06	7.14	7.10	0.290 b	0.252	0.271 b
8	4	4	30 c	19	50 b	1790 c	19 b	7.13	7.19	7.16	0.265 b	0.259	0.262 b
16	5	4	51 b	20	73 b	2481 ab	24 b	7.12	7.24	7.18	0.357 b	0.258	0.307 b
32	6	4	224 a	35	264 a	3088 a	64 a	6.89	7.11	7.00	0.717 a	0.316	0.516 a
		SE				392	14.40	0.12	0.12	0.11	0.083	0.034	0.057
		$LSD_{(0.1)}$				687	25	0.20	0.20	0.20	0.146	0.060	0.099
		CV	9	17	8	25	72.3	2.3	2.3	2.3	32.4	17.9	25.3
		MSE				306813	414.9	0.02703	0.02679	0.02621	0.01388	0.002318	0.006387
		Gr Mean				2243	28.2	7.1	7.2	7.1	0.4	0.3	0.3

CANARY YIELD (kg/ha)

Tons/ac	Trt	N	Grain	Straw	Total
0	1	4	465 b	1973 bc	2438 bc
2	2	4	468 b	2027 bc	2495 bc
4	3	4	509 b	1844 bc	2353 c
8	4	4	470 b	1805 c	2275 c
16	5	4	700 a	2502 ab	3203 ab
32	6	4	681 a	3022 a	3703 a
		SE	79.44	394.09	447.45
		$LSD_{(0.1)}$	139	691	784
		CV	20.5	25.4	23.1
		MSE	12621.0	310635	400428
		Gr Mean	548.8	2195.4	2744.2

FALL SOIL SAMPLES

	Avail. N		
	0-30	30-60	0-60
	45 b	30	76 b
	34 b	23	58 b
	42 b	36	79 b
	40 b	29	71 b
	38 b	41	80 b
	73 a	50	125 a
	8	11	7

Nutrients and yield in kg/ha

Where only **CV** is given, means are back-transformed

2002: Dr. Jeff Schoenau's Poultry Manure Experiment at Regina

Coordinated by Dr. S.P. Mooleki **2002 Canary crop quality**

This file: C:\~Jeff\2002work\Data2002\Combined\02Crop&SL1&2JJPoulAV.xls

This file: C:\~Jeff\2002work\Data2002\Combined\02Crop&SL1&2JJPoulTT.xls

January 16, 2003

MEANS

			N Yield			P Yield			Grain		
Tons/ac	Trt	N	Grain	Straw	Total	Grain	Straw	Total	Protein	N conc	P conc
						(kg/ha)			%	mg/g	
0	1	4	12.6 b	10.3 c	22.9 b	2.6 b	1.3	3.9	17.1	27.3	5.6
2	2	4	12.1 b	8.6 c	20.7 b	2.5 b	1.2	3.7	15.9	25.5	5.4
4	3	4	13.6 b	9.1 c	22.7 b	2.8 b	1.4	4.2	16.5	26.5	5.5
8	4	4	12.5 b	7.9 c	20.4 b	2.7 b	1.2	3.9	16.6	26.5	5.7
16	5	4	20.5 a	13.9 b	34.5 a	3.8 a	1.2	5.0	18.3	29.3	5.4
32	6	4	21.2 a	19.0 a	40.1 a	3.6 a	1.6	5.3	19.3	30.9	5.4
		SE	2.0	2.0	3.4	0.4	0.3	0.6	1.2	2.0	0.2
		$LSD_{(0.1)}$	3.5	3.4	6.0	0.7	0.5	1.1	2.1	3.4	0.3
		CV	18	24	18	20	31	20	10	10	5
		MSE	8.0690	7.6730	23.230	0.3611	0.1689	0.7598	2.9740	7.6140	0.0745
		Gr.Mean	15.413	11.464	26.876	3.006	1.328	4.334	17.280	27.658	5.485

4.5 PAMI Analysis 2003

Soil characteristics in the 0 to 6 in (0 to 15 cm) depth were analyzed in Spring 2003 to determine the soil quality effects of a single manure application in Spring 2001. Soil pH, salinity, and soil organic carbon only changed slightly over the test period except at the 32 tons/ac (71 tonnes/ha) rate where organic carbon increased from 2.5 to 2.8%. Total N, total P, and total K all increased as manure rates increased.

In Spring 2003, the field was pre-worked and seeded for the third year in a row to canary seed. As continuous cropping of the same crop for many years results in disease and weed problems, PAMI made a specific request to the farmer co-operator to change the rotation away from canary seed in 2003. Unfortunately the request was unsuccessful.

Similar to 2002, seed yields were low due to drought stress and grasshopper damage. Only the 16 and 32 tons/acre (36 and 72 tonnes/ha) treatments resulted in significantly higher yields compared to the control (**Figure 8**).

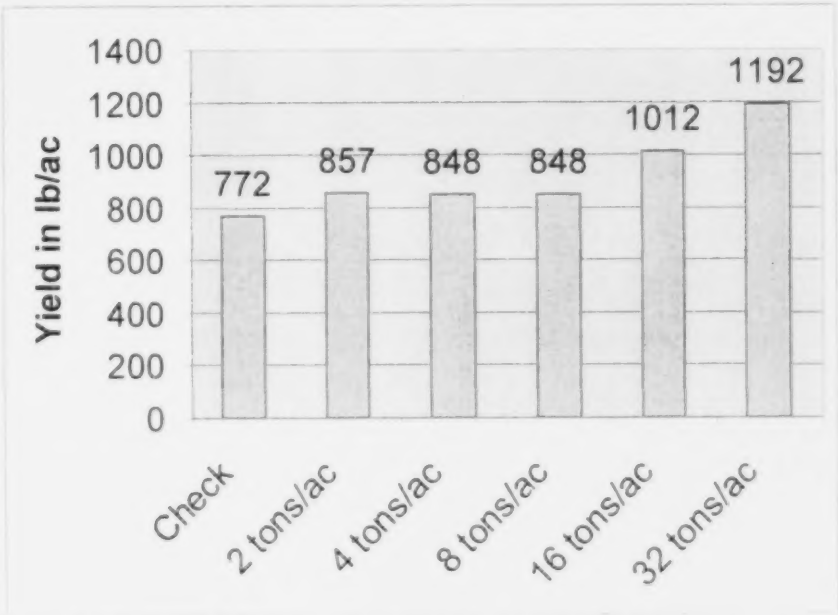

Figure 8. Effect of Poultry Manure on Canary Seed Yield 2003.

4.6 University of Saskatchewan Analysis 2003

4.6.1 Spring 2003 - 0.5 to 6 in (1 to 15 cm) Depth Soil Characteristics

There was a trend for decreased soil pH as manure application increased but only by 0.1 pH unit. The decrease was most evident at the high (32 tons/ac [71.7 tonnes/ha]) application rate. The small reduction in pH is not surprising as the high clay content soil is highly buffered.

Poultry manure addition had no real effect on E.C. (salinity). The 32 tons/ac (71.7 tonnes/ha) rate did have slightly but statistically significant higher E.C. than control: 0.46 mS/cm in 32 tons/ac (71.7 tonnes/ha) rate versus 0.35 mS/cm in the control, but this change is not biologically significant.

The soil organic carbon (O.C.) was not significantly increased by poultry manure addition, except at the 32 tons/ac (71.7 tonnes/ha) rate where the organic carbon increased from 2.5% in the control to 2.8% at the 32 tons/ac (71.7 tonnes/ha) rate. It is not surprising that there is no large effect on organic carbon, since there was only a single application of manure.

Poultry manure application increased total N and the increase is proportional to rate. The 32 tons/ac (71.7 tonnes/ha) rate increased total N in the top 6 in (15 cm) by ~ 893 lb N/ac (1,000 kg N/ha). Much of this increase is likely attributable to build-up of organic N rather than nitrate.

Poultry manure application also significantly increased the total P. The increases were not huge, but total P went from 1,357 lb/ac (1,520 kg/ha) in the control to 1,652 lb/ac (1,850 kg/ha) at the 16 tons/ac (35.9 tonnes/ha) rate and to 2,357 lb/ac (2,640 kg/ha) at the 32 tons/ac (71.7 tonnes/ha) rate. These results indicate the need to monitor P loading with poultry manure. It should be noted that the highest manure application rate added about 482 lb P/ac (540 kg P/ha) but only 22 lb/ac (25 kg/ha) of water soluble inorganic P. The low content of water-soluble P in the manure, along with the high P sorption capacity of this heavy clay soil, like Plenty, is reflected in a similar, non-significant increase in Kelowna extractable P, despite the large amount of total P added at these high rates.

Poultry manure addition also produced large increases in Kelowna extractable K with 607 lb K/ac (680 kg K/ha) added at the 32 tons/ac (71.7 tonnes/ha) rate resulting in Kelowna extractable K going from 1,071 to 1,875 lb K/ac (1,200 to 2,100 kg K/ha).

The control, 2, 4, 8, and 16 tons/ac (4.5, 9.0, 17.9, and 35.9 tonnes/ha) rates had similar nitrate N contents in the 0 to 6 in (0 to 15 cm) depth. However, it should be noted that these manure additions were made two years previous. There was not a lot of residual

impact at these rates after two years. However, the 32 tons/ac (71.7 tonnes/ha) rate did have significantly higher nitrate and ammonium content in the surface soil that likely reflects continued mineralization of organic N.

The 16 and 32 tons/ac (35.9 and 71.7 tonnes/ha) rates had higher sulfate contents, so poultry manure may be an adequate source of sulphur, similar to cattle manure.

4.6.2 Canary Seed Yields

Drought and grasshoppers were a problem at this site in 2003. In addition, the rotation used by the farmer co-operator is continuous canary seed.

Compared to the control, the 2, 4, and 8 tons/ac (4.5, 9.0, 17.9 tonnes/ha) rates had slightly higher yields, but the increases were not statistically significantly different. The 16 tons/ac (35.9 tonnes/ha) rate produced significantly higher yield than the control 241 lb/ac (270 kg/ha higher) and the 32 tons/ac (71.7 tonnes/ha) rate the highest yields at 1,192 lb/ac (1,335 kg/ha) versus 772 lb/ac (865 kg/ha) in the control. Straw yields followed a similar trend. Therefore, as in the previous year, it was only the 16 and 32 tons/ac (35.9 and 71.7 tonnes/ha) rates that have significant residual benefit. This is probably related to N but may be related to other factors as well. A rate of addition of 16 tons/ac (35.9 tonnes/ha) once every three years may be the best management practice.

Schoenau & Co. Poultry Manure Project Regina, SK. Site 2003

2003 Canary Seed Crop Harvest

Rate of Manure Application			Crop Harvest Fall 2003				Spring 2003 Soil Samples																	
			Grain Yld.		Straw Yld.		pH		Elect.Cond.		Org.Carbon		Total N		Total P		Kelowna K		Kelowna P		NO3-N		NH4-N		SO4-S
							0-15 cm																	
Trt	Poultry Manure Rate (Tonnes/ac)	N																						
1	0	4	865	134	1538	465	8.3	0.2	0.15	0.04	2.5	0.1	4242	294	1520	113	1202	241	6.5	3.7	30.6	6.1	17.2	4.7	6.7	13.9
2	2	4	960	242	1760	425	8.3	0.0	0.34	0.06	2.3	0.3	5204	544	1425	162	1371	219	4.7	0.5	34.5	13.0	14.1	1.6	7.7	9.4
3	4	4	950	224	1480	345	8.2	0.1	0.33	0.05	2.5	0.3	4193	647	1534	184	1509	377	5.0	0.9	33.3	12.7	15.1	2.2	7.9	3.8
4	8	4	950	195	1695	282	8.2	0.1	0.34	0.02	2.4	0.4	4335	645	1628	219	1466	493	6.2	2.8	27.0	10.3	13.9	3.3	3.5	4.4
5	16	4	1133	143	2126	371	8.1	0.0	0.37	0.02	2.5	0.2	4486	411	1853	314	1796	341	5.2	1.4	35.6	9.7	16.5	6.4	14.4	0.5
6	32	4	1305	95	2478	461	8.1	0.1	0.46	0.06	2.5	0.1	5247	295	2649	355	2104	163	6.1	1.3	50.9	13.7	22.6	7.1	29.3	19.1
		LSD (0.05)	235		522		0.1		0.05		0.3		553		236		402		2.5		9.7		8.0		10.9	

Rate of Manure Application			Crop Harvest Fall 2003			
			Grain Yld.		Straw Yld.	
Trt	Poultry Manure Rate (Tonnes/ac)	N				
1	0	4	865	134	1538	465
2	2	4	960	242	1760	425
3	4	4	950	224	1480	345
4	8	4	950	195	1695	282
5	16	4	1133	143	2126	371
6	32	4	1305	95	2478	461
		LSD (0.05)	235		522	

Note 1. Grain and Straw yield means in kg/ha

2. Means in the first column are followed by Std deviations in the second column

3. N=Number of observations

4. Total N, Total P, Kelowna N, Kelowna P, Nitrate, Ammonium, and Sulfate means are in kg/ha

5. E.C. means in mS/cm

6. Organic Carbon means in percent (%)

Schoenau & Co. Swine,Poultry and Cattle Manure Projects For 2003

Site: Regina Poultry, SK.

Regina Poultry Manure Site

Rate of Manure Application

Trt	Rate (tons ac^{-1}) 2001	N	Fall Soil Nitrate and Ammonium (kg ha^{-1})							
			NO3-N (0-30 cm)		NH4-N (0-30 cm)		NO3-N (30-60 cm)		NH4-N (30-60 cm)	
1	0	4	23	3.3	48.4	7.4	13.4	5.9	42.8	10.6
2	2	4	27.4	13.9	43.1	13.5	12.6	1.3	37.5	7.6
3	4	4	27.2	9.6	40.5	14.8	13.1	3.3	36.3	14.9
4	8	4	25.9	14.6	37.6	11.9	18.7	3.7	41.3	7.7
5	16	4	21.9	2.2	36.9	6.4	10.4	2.4	36.1	8.2
6	32	4	40.9	15	44.8	11.8	19.4	5.9	39.6	5.8
		$LSD_{(0.10}$	14.2		14.3		5.4		11.5	

Note: Means in the first column are followed by Std.deviations in the second column

5. Conclusions

Due to various circumstances, the project was delayed by one year. Poultry manure was successfully applied and incorporated in the plots in Spring 2001. The plots were seeded to canary seed in Spring 2001, 2002, and 2003. Yield samples were harvested with a small plot combine in Fall 2001, Fall 2002, and Fall 2003. Limited rainfall in 2001 resulted in poor seed yields. With the exception of the 2 tons/ac (4.5 tonnes/ha) rate, each increase in manure application rate resulted in incrementally higher seed yield. In 2002 and 2003, only the 16 and 32 tons/ac (35.9 and 71.7 tonnes/ha) rates applied in Spring 2001 had significant enough residual N carryover to boost seed yield. Based on an analysis of all data, a manure application rate of 16 tons/ac (35.9 tonnes/ha) once every three years may be the best management practice.

6. Personnel and Expenses

6.1 PAMI Manpower Supplied

It is PAMI's policy to charge rates that include salary and benefits of employees as well as overhead. These charge rates do not include profits, and to ensure that overhead is not charged to the project. Indirect support services, management time and use of PAMI equipment are provided at no cost. It has been calculated that this adjustment removes more than overhead costs from actual charge rates. It is PAMI's policy not to release individual salary information. The following are total project costs and manpower expended to December 31, 2003.

7. Project Schedule

The following is a revised tentative scheduling of the project.

	Start	Completion
Locate Research Site		October 23, 2000
Stake Plots		October 24, 2000
Calibrate Equipment, Apply Treatments, *Soil Sampling, Manure Sampling*	April 20, 2001	May 5, 2001 **(Actual May 7, 2001)**
Tour Site	June/July 2001	June/July 2001
Harvest Samples, Process Samples, Analyze Data, *Soil Sampling*	August 30, 2001	November 1, 2001
Tour Site	June/July 2002	June/July 2002
Harvest Samples, Process Samples, Analyze Data, *Soil Sampling*	August 30, 2002	November 1, 2002
Tour Site	June/July 2003	June/July 2003
Harvest Samples, Process Samples, Analyze Data, *Soil Sampling*	August 30, 2003	November 1, 2003
Final Report	December 1, 2003	March 31, 2004

Note: Italicized tasks to be performed by the Department of Soil Science, University of Saskatchewan

Appendix I

Poultry Manure Analysis

Concentrations in *Poultry Manure* (wet basis) Applied at REGINA Crop Site in Spring 2001

Values are means of sub-samples collected and analyzed separately

Tot. N	NH4	NO3	Tot. P	Avail P	K	Ca	Mg	Cu	Fe	Mn	Zn	B	Na
ug/g wet manure													
14632	2154	-		7512	354	9483	31264	3744	33.0	1088	206	197	18.6	1311

Application rates of nutrient in kg/ha

Highest Rate
32 tons/acre (71.6 tonnes / ha)
(wet)

1045	154	-		538	25.3	679	2453	268	2.4	77.9	14.7	14.1	1.33	93.8